

ICESat (GLAS) Science Processing Software Document Series

Volume #

GLAS Standard Data Products Specification - Level 1 Version 4.0

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November 2001

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Foreword

This preliminary document defines the Level One GLAS standard data products. This Standard Data Products Specification is developed under the structure of the NASA STD-2100-91, a NASA standard defining a four-volume set of documents to cover an entire software life cycle. Under this standard a section of any volume may, if necessary, be rolled out to its own separate document. This document is a roll out of the GLAS ESDIS Software Detailed Design Specification under the Product Specification Volume.

The GEOSCIENCE LASER ALTIMETER SYSTEM (GLAS) is a part of the EOS program. This laser altimetry mission will be carried on the spacecraft designated EOS ICESat (Ice, Cloud and Land Elevation Satellite). The GLAS laser is a frequency-doubled, cavity-pumped, solid state Nd:YAG laser.

This document addresses the data flow, interfaces, record and data formats associated with the GLAS Level 1 standard data products. GLAS Level 1 standard data products are composed of Level 1A and Level 1B data products. The term “standard data products” refers to those EOS instrument data products listed in the Earth Science Data and Information System (ESDIS) Project data base that are routinely generated within the EOSDIS Distributed Active Archive Center (DAAC) or Science Computing Facilities (SCFs). Each data product has a unique Product Identification code assigned by the EOS Senior Project Scientist.

Level 1A and Level 1B Data Products are composed from those Level 0 data that have been reformatted or reversibly transformed to corrected and calibrated data in physical units at the full instrument rate and resolution.

This document was prepared by the Observational Science Branch at NASA GSFC/WFF, Wallops Island, VA, in support of B. E. Schutz, GLAS Science Team Leader for the GLAS Investigation. This work was performed under the direction of David W. Hancock, III, who may be contacted at (757) 824-1238, hancock@osb1.wff.nasa.gov (e-mail), or (757) 824-1036 (FAX).

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Section 1

Introduction

1.1 Identification of Document

This document is identified as the GLAS Level 1 Standard Data Products Specification. The unique document identification number within the GLAS Standard Data Software documentation numbering scheme is GLAS-DPS-2621. Progressive editions of this document will be uniquely identified by the cover and page date marks.

1.2 Scope of Document

This document addresses the purpose, usage, and description of the GLAS Level 1 Standard Data Products. The intended audience for this document is the GLAS Science and Instrument Teams, the ESDIS Project and related focus teams, the community of EOS data users and investigators, and the GLAS Standard Data Software Development Team. This document does not provide details of the archive and distribution processes at the DAAC.

1.3 Purpose and Objectives of Document

The purpose of the GLAS Level 1 Standard Data Products Specification is to provide a high-level descriptive document for the data products. This document describes the purpose, usage, content, and format of the GLAS Level 1 Data Products. It describes the structure, physical storage, organization, and access characteristics of the GLAS Level 1 Data Products. The document additionally describes file transfer methods to support product access, the data flow associated with the data products, and the data storage and generation characteristics of the data products.

1.4 Document Organization

This document's outline is assembled in a form similar to those presented in the NASA Software Engineering Program [Information Document 2.3a].

1.5 Document Status and Schedule

This document will be updated and released as required.

1.5.1 Document Change History

Document Name: GLAS Standard Data Products Specification - Level 1		
Version Number	Date	Nature of Change
Preliminary	December 31, 1995	Original Version
Version 1.2	March 1998	Text, Figures, and Tables updated for Level 1 data updates, for the change to GLAS standard data product generation being performed at the GLAS SCF, and change of the spacecraft name to ICESAT.
Version 2.0	January 1999	Updates to Data Product Contents
Version 3.0	November 2000	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V1 release.
Version 4.0	November 2001	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V2 release.

Related Documentation

2.1 Parent Documents

The GLAS Level 1 Standard Data Products Specification is considered a “roll-out” from the Product Specification as the parent document or volume. Specific topics pertaining to data descriptions are located in the External Interface section under the Detailed Design document template.

This document is subordinate to any top-level mission or instrument management plan documents, and as such, recognizes these documents as external parent documents in lineage. The recognized external EOSDIS and GLAS parent documents superior to the GLAS Level 1 Standard Data Products Specification are listed below.

- a) *NASA Earth Observing System Geoscience Laser Altimeter System GLAS Science Requirements Document*, Version 2.01, October 1997, Center for Space Research, University of Texas at Austin.
- b) *GLAS Science Software Management Plan*, NASA/TM-1999-208641/Ver.3/Vol.1, August 1998, NASA Goddard Space Flight Center, Wallops Flight Facility.

2.2 Applicable Documents

The following documents are related to, or contain policies or references pertinent to the contents of the GLAS Level 1 Standard Data Products Specification.

- a) *Data Production Software, Data Management, and Flight Operations Working Agreement for GLAS*, TBD, NASA Goddard Space Flight Center.
- b) *Atmospheric Delay Correction to GLAS Laser Altimeter Ranges*, Algorithm Theoretical Basis Document, Version 0.3, December 1996, Massachusetts Institute of Technology.
- c) *Algorithm Theoretical Basis Document for the GLAS Atmospheric Channel Observations*, Version 0 (Preliminary), December 1995, Goddard Space Flight Center.
- d) *Geoscience Laser Altimeter System: Surface Roughness of Ice Sheets*, Algorithm Theoretical Basis Document, Version 0.3, December 1996, University of Wisconsin.
- e) *Determination of Sea Ice Surface Roughness from Laser Altimeter Waveform*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1995, The Ohio State University.
- f) *Laser Footprint Location and Surface Profiles*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1996, Center for Space Research, The University of Texas at Austin.

- g) *Precision Orbit Determination (POD)*, Algorithm Theoretical Basis Document, Version 0.1, December 1996, Center for Space Research, The University of Texas at Austin.
- h) *Precision Attitude Determination (PAD)*, Algorithm Theoretical Basis Document, December 1996, Center for Space Research, The University of Texas at Austin.
- i) *The Algorithm Theoretical Basis Document for Level 1A Processing*, November 1999, Version 0, GSFC/Wallops Flight Facility.
- j) *GLAS Atmospheric Data Products*, Algorithm Theoretical Basis Document, Version 4.0, July 2000, Goddard Space Flight Center.

2.3 Information Documents

The following documents are provided as sources of information that provide background or supplemental information that may clarify or amplify material in the GLAS Level 1 Standard Data Products Specification.

- a) *NASA Software Documentation Standard Software Engineering Program*, NASA, NASA-STD-21000-91, July 29, 1991.
- b) *The Geoscience Laser Altimetry/Ranging System*, IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-25, No. 5, September 1987.
- c) *EOS Altimetry/GLAS Phase-A Study*, NASA Goddard Space Flight Center, November 1995.
- d) *Memorandum: GLAS Data Products, Center for Space Research*, University of Texas at Austin, December 23, 1993.
- e) *GLAS Science Computing Facility (SCF) Plan*, NASA Goddard Space Flight Center, Wallops Flight Facility, October 1997.

Purpose and Description of the Data Products

3.1 Purpose of the Data Products

The purpose of the GLAS Level 1 Standard Data Products is to provide the initial reduced GLAS instrument data to the GLAS Science Team and to provide input to the Level 2 data product generation. The GLAS Level 1 Data Products are monitored for data quality and instrument performance. The GLAS Level 1 Data Products are available to the EOS data user community for analysis purposes from the EOSDIS DAAC product storage facility.

3.2 Description of the Data Products

Table 3-1 identifies the Level 1 Data Products. The data products are integer-binary format files containing fixed-length records of data with the exception of the GPS data in the GLA04 product. The GPS data is stored in ASCII format. Each data record consists of several data elements. An element is either an Item or an Array of Items. The elements are measurements and associated correction values obtained from specific GLAS science algorithm sets. The data products will be formatted in scaled integer binary format with both attached and unattached metadata containing identification, processing history, and data descriptive information.

Table 3-1 GLAS Level 1 Standard Data Products

Product ID (Identification)	Product Name	Product Level
GLA01	Altimetry Data File	1A
GLA02	Atmosphere Data File	1A
GLA03	Engineering Data File	1A
GLA04	SRS and GPS Data File	1A
GLA05	Waveform-based Elevation Corrections File	1B
GLA06	Elevation File	1B
GLA07	Backscatter File	1B

n/a - Not applicable

Figure 3-1 illustrates the source Level 0 data being processed to generate the Level 1 Data Products on the I-SIPS (ICESAT Science Investigator-led Processing System). The GLAS science data processing software transforms the instrument data into the appropriate time-ordered, along-track 1064 nanometer and 532 nanometer Level 1A and Level 1B data parameters and elements. Additional Level 1A science processing algorithms retrieve the GPS receiver data and stellar reference system data and

include in the Level 1A product file records. Instrument engineering monitor data along with derived calibration data items are recorded. The Level 1 Data Products are recorded with sufficient detail so as to allow the recovery of the original input elements. In support of the GLAS Science Team, the GLAS Operations Team performs quality assurance at the I-SIPS and returns data quality and descriptive metadata to EOSDIS for incorporation in the EOS data base system.

The specific details of the data product structure, content, format, and data element details will be presented in Section 6. Data sizing, storage burden, and physical media details are provided in Section 5.

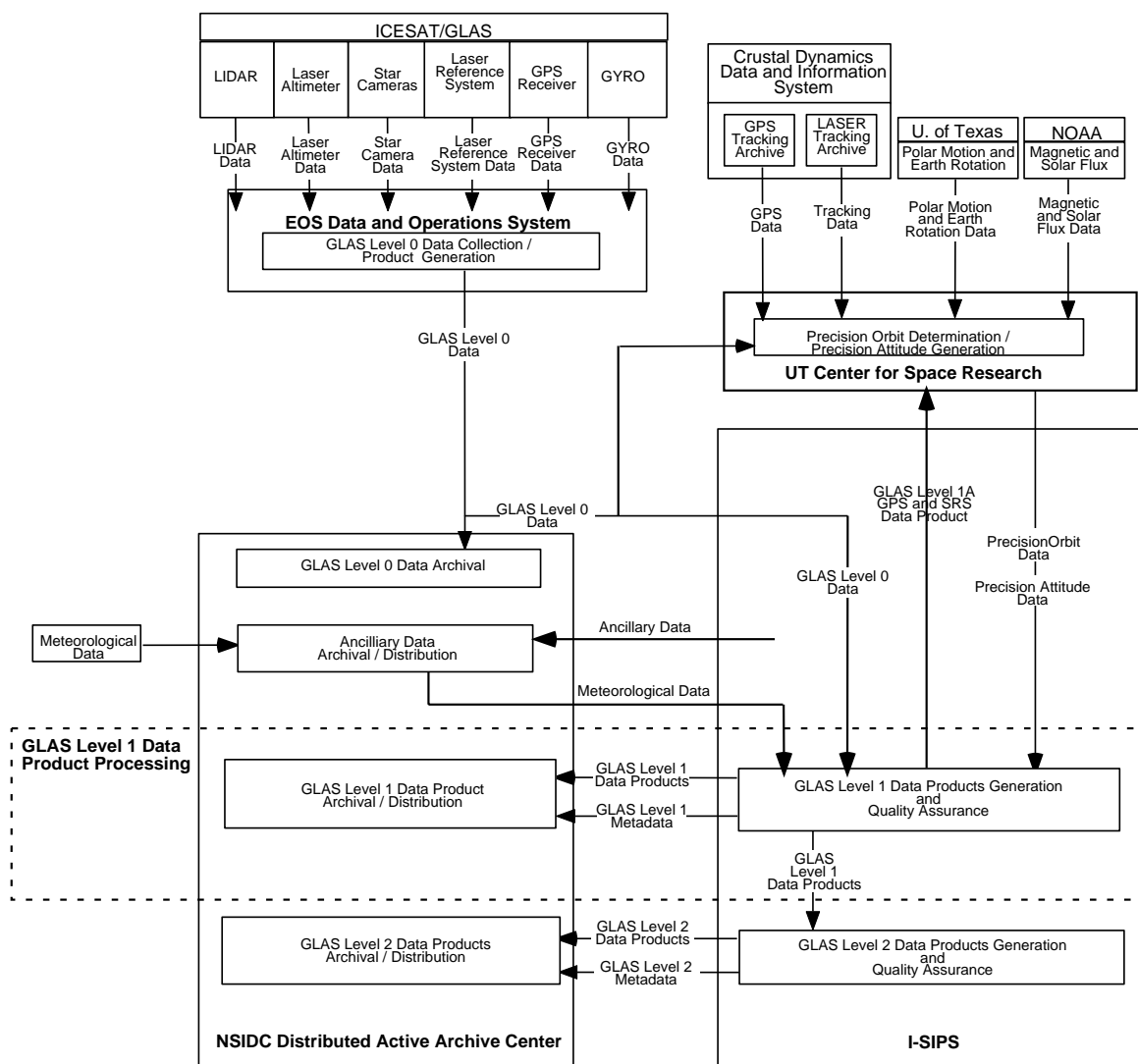


Figure 3-1 Level 1 Data Products Within the Processing Hierarchy

Section 4

Environment

4.1 Hardware Characteristics and Limitations

The required input to the software that creates the Level 1 Data Products is the GLAS Level 0 instrument and spacecraft telemetry data. The Level 0 data is available from EDOS in Production or Expedited Data Sets. The GLAS Level 1A and Level 1B Standard Data Products will be generated on the I-SIPS.

The I-SIPS consists of distributed UNIX operating system-based computers operating under the standard UNIX environment that support the GLAS Science Team operations including the standard data product generation and quality assurance monitoring. The GLAS Level 1A and Level 1B Data Products and their metadata (including QA data) are archived at the DAAC. The Level 1A and Level 1B associated data description and support information are included in the EOSDIS data base to facilitate EOS client inquiry and retrieval activities. The distribution management function of the DAAC allows clients to perform direct search and access of the Level 1A and Level 1B data or to request preparation of Level 1 Data Products.

4.2 Data Products Medium and Characteristics

The Level 1 Data Products will be delivered to the DAAC and archived under the Earth Sciences data collection within the DAAC's data storage and archival subsystem. The storage system will contain not only the Level 1 Data Products, but will also contain data descriptions and data advertisements (i.e., textual descriptive and abstract information, also called metadata).

The Earth Science data are implemented in the current-EOSDIS system through a hierarchical storage manager interface. Physical media supported by the storage system interface will include the disk storage subsystems, magnetic or optical media subsystems, and tiered archive robotics storage subsystems. EOSDIS clients can directly access the GLAS Level 1A and Level 1B data from the DAAC and can copy the data products to their host processors.

The Level 1 Data Products will be available to the GLAS Science Team through the ICESat SCF. See Information Document 2.3e for a detailed description of the ICESat SCF.

4.3 Protocol and Conventions

Protocols and conventions specific to the GLAS SCF will be developed by the GLAS Science Team and documented in the SCF Plan [Information Document 2.3e]. When interfacing to the DAAC, the I-SIPS will comply with procedures, conventions, and protocols as defined by the EOSDIS.

Data definition terminology specific to the GLAS Level 1 Data Products is presented in the Glossary at the end of this document. Figure 4-1 “Data Representation” depicts a schematic of the standard data representations used in the GLAS Level 1 Data Products. These data structures will be used in the Section 6.0 generic data description and in the Appendix C detailed data description of the GLAS Level 1 Data Products.

Data Types, Sizes, and Representations

Conventions: byte 0 is the most significant byte (MSB)
bit 0 is the least significant bit (lsb)
S = the sign bit

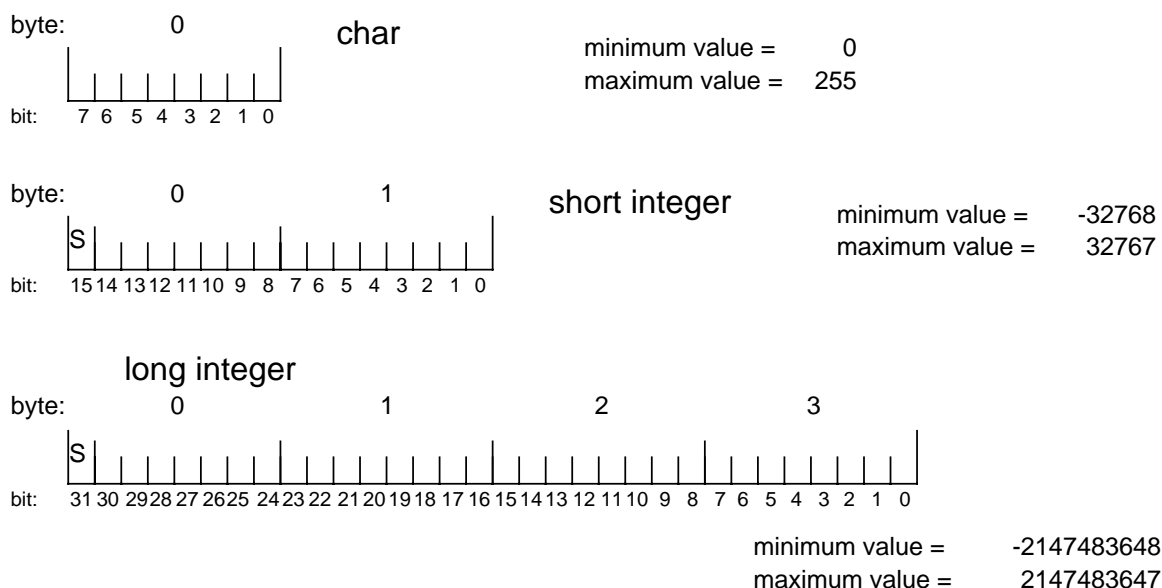


Figure 4-1 Data Representation

4.4 Failure Protection, Detection, and Recovery Features

The team supporting operations at the I-SIPS will be responsible for failure protection, detection, and recovery of the GLAS Level 1A and Level 1B Data Products stored on the I-SIPS. Initial GLAS Level 1A and Level 1B Data Products error detection is performed during product generation as part of the product and processing quality assurance activity. The GLAS Level 1A and Level 1B Data Products will be “backed up” under the routine operational functions performed at the I-SIPS. In the event of failure or error detection in the active working or archive storage, recovery would be performed from backup media or from the EOSDIS DAAC archive.

The EOSDIS will be responsible for failure protection, detection, and recovery of the GLAS Level 1A and Level 1B Data Products archived at the DAAC.

Data Flow Characteristics

5.1 Volume, Size, and Frequency Estimates

The expected daily data storage burdens for the GLAS Level 1A and Level 1B Standard Data Products are listed in Table 5-1 “GLAS Level 1 Data Product Daily Storage Burden”. This estimate is based on the following EOS ICESat operational assumptions. The spacecraft will orbit the Earth at an inclination of 94 degrees and a nominal altitude of 600 kilometers in a circular orbit. The orbit (groundtrack) repeat cycle is one-half year based on a frozen orbit. The EOS ICESat orbit period will be approximately 100 minutes.

Table 5-1 GLAS Level 1 Data Product Daily Storage Burden

Product ID	Volume (MBytes per Day)
GLA01	2340
GLA02	4957
GLA03	99
GLA04	1967
GLA05	1466
GLA06	470
GLA07	6076

n/a - Not applicable

5.2 Data Transfer and Transmission

The GLAS Data Products and associated descriptive metadata will be delivered to the EOSDIS DAAC archival facility through the EOS Science Network access arrangement or off-line via storage media. The GLAS Level 1A and Level 1B Data Products delivered to the DAAC processing subsystem will be designated for fail-safe functions. The GLAS Science Team will have access to the GLAS Level 1 Data Products through the GLAS SCF using TCP/IP and standard UNIX command operations.

Data access procedures to retrieve the GLAS Level 1A and Level 1B Standard Data Products from the EOSDIS DAAC will be provided by the EOSDIS DAAC.

5.3 Timing and Sequencing Characteristics

The GLAS Level 1A and Level 1B Standard Data Products are generated as product files consisting of processed Level 0 data. The basic aggregation of the GLAS Level 1 Data Products is the descriptive information in the header records and GLAS Data

Elements in the data records. Records consists of one-second of reduced GLAS instrument, GPS receiver and stellar reference system data, and location data. The exception is the Engineering Data File (GLA03) with records that span 16 seconds. The data parameters and elements contained within the records are groups of forty hertz, five hertz, and one hertz rate data.

All data records within the GLAS Level 1 Data Product files will be in ascending time order based on the first pulse time tag or the first sample time tag. All parameters and elements contained within the records are synchronous at either forty hertz, five hertz, or one hertz. The GLAS instrument and the EOS ICESat spacecraft are expected to operate continuously for at least three years with a goal of five years.

5.4 Recipients and Utilization

The GLAS Science Team and the EOSDIS DAAC are the initial recipients of the Level 1 Data Products. At the I-SIPS, the Level 1 Data Products will be used to generate the Level 1 metadata and the Level 2 Data Products. The metadata (delivered to the EOSDIS DAAC) will include data quality evaluation and statistical reporting on the GLAS Level 1 Data Products to quantify and qualify the products for EOS community usage. The GLAS Science Team will use the Level 1 Data Products for research and analysis.

The subsequent audience for the GLAS Level 1 Data Products is the scientific, governmental, and educational community sectors who will obtain the products from the EOSDIS DAAC.

5.5 Access

The GLAS Level 1 Data Products will be available to the GLAS Science Team from the GLAS SCF. Access to the GLAS SCF is controlled by the GLAS Science Team.

While EOS is intended to be a globally available and utilized mission program, access to the data is still operated under a security and integrity program to protect the data and data system resources from unauthorized or destructive use. Procedures for data access are defined by the EOSDIS DAAC.

Section 6

Data Product Definitions

6.1 Data Product Structure

The GLAS Level 1 Data Products will be generated as scaled integer binary files. Each file will contain appropriate header, labelling, and metadata information and a collection of one-second records of GLAS instrument, sensor, and time data. Exceptions are the GLA03 product which contains 16-second records and the GLA04 product which contains ASCII GPS data.

6.2 Labeling and Identification

Each of the GLAS Level 1 Data Products is uniquely identified by a GLAS standard file name. The form of this file name is

GLAxx_mmm_pr_ccc_tttt_s_nn_ff.dat

Specific elements within the file name are described in Table 6-1.

Table 6-1 GLAS File Naming Keys

Key	Description
xx	The GLAS Product ID (01-15)
mmm	release number for process that created the produce (CCB assigned-combination of software and data)
p	repeat ground track phase
r	reference orbit number
ccc	cycle of reference orbit for this phase
tttt	track within reference orbit
s	segment of orbit
nn	granule version number (the number of times this granule is created for a specific release)
ff	file type (numerical, CCB assigned for multiple files as needed for data of same time period for a specific GLAxx, i.e. multi-file granule)

The structure and contents of the GLAS Level 1 Data Product headers and labels are contained in Appendix A.

6.3 Data Product Substructure Descriptions

Full data product descriptions are provided online in a hyperlinked format at the WFF GLAS website. The URL for product descriptions is:

http://glas.wff.nasa.gov/v2_products/

Table 6-2 lists the fields shown in each data product description entry.

Table 6-2 GLAS Data Product Description Fields

Field	Description
ID	GLAS File ID (GLA01, GLA02, etc).
Name	Descriptive name.
Product Type	Product Type (Standard Ancillary).
Product Level	Product Level (L0,L1A,L1B,L2,L3).
Science Discipline	Primary associated science discipline.
Investigator	Primary investigator.
Temporal Resolution	Nominal time span, in seconds, of each data record within a file.
Temporal Coverage	Nominal time span, in minutes, of data contained within a file.
Horiz Res Coverage	Horizontal coverage, in meters, over Earth's surface for each instrument measurement.
Vert Res Coverage	Vertical coverage, in meters, over the Earth's surface for each instrument measurement.
Instrument Name	Source instrument for the file (GLAS).
Archive Site	Location at which this file will be permanently archived.
File Disposition	Usage indicator with the following definitions: Archive - a file that is permanently archived after it is created. Interim - a file that is created for use by a subsequent process, but is not archived. Permanent - a file that is assumed to be kept in the processing environment for repeated access by one or more processes. Temporary - a file that is created by a process during its execution and is then deleted after termination. Transfer to SCF - similar to an Interim file, except the process that uses it is at an SCF.
Root/External Flag	A flag signifying whether this file is: 0 : neither of the following. 1 : the head-of-chain (Level 0 data) of an instrument's data stream. 2 : a file from an external source.
Filespec	Standard GSAS naming convention specification for the file.
Source	A flag giving source data system of this file.
Frequency (per day)	Number of times processing PGE is executed.

Table 6-2 GLAS Data Product Description Fields (Continued)

Field	Description
Files per Granule	Number of physical files per each granule.
CPU (min)	Number of processing minutes required to produce a granule of this data.
MB per Day	Estimated amount of this data processed each data.
Record Size (bytes, 0=variable)	Size, in bytes, of a single record of data. 0 indicates a variable sized record.
Granule Size (MB)	Size, in megabytes, of a granule.
Granules per Day	Number of granules normally processed per day.
Revs per Granule	Number of earth revolutions contained in one granule.
Description	Text description.
Comment	Text comments.

6.4 Detailed Data Descriptions

Detailed data descriptions are provided at the website listed above. These descriptions provide details for each value within a product file. Table 6-3 lists the fields shown in each detailed data description entry.

Table 6-3 GLAS Detailed Data Description Fields

Field	Description
ID	Unique identifying name of the product variable.
Name	Descriptive name of the product variable.
Prod Variable Type	Product (Unscaled) Variable Type. i1b = Integer, 1 byte i2b = Integer, 2 bytes i4b = Integer, 4 bytes r4b = Real, 4 bytes r8b = Real, 8 bytes etc...
Unsigned	Flag indicating if the variable is unsigned.
Prod Dimension 1	1st array dimension of the product variable (if applicable).
Prod Dimension 2	2nd array dimension of the product variable (if applicable).
Prod Minimum Variable	Minimum value supported in product variable.
Prod Maximum Variable	Maximum value supported in product variable.
Is a Flag	Flag indicating if the variable is a flag.

Table 6-3 GLAS Detailed Data Description Fields (Continued)

Field	Description
Invalid Value	<p>Indicates what identifies the filed as being invalid.</p> <p>None = variable cannot be invalid. gd_invalid_xxx = datatype-specific value which indicates the variable is not valid. [variable name] = name of the flag to check in order to determine validity of the variable.</p>
Prod Units	Units of the product variable.
Alg Variable Name	Unique identifying name of the algorithm variable.
Alg Variable Type	<p>Algorithm (Scaled) Variable Type.</p> <p>i1b = Integer, 1 byte i2b = Integer, 2 bytes i4b = Integer, 4 bytes r4b = Real, 4 bytes r8b = Real, 8 bytes etc...</p>
Alg Dimension 1	1st array dimension of the algorithm variable (if applicable).
Alg Dimension 2	2nd array dimension of the algorithm variable (if applicable).
Alg Units	Units of the algorithm variable.
Alg Scale	Scale factor to use when converting between product and algorithm variables. (algorithm = product * scale)
Special Conversions	Flag identifying if a special conversion routine is required when converting to/from product and algorithm values.
A2P Conversion	Name of special routine which converts from Algorithm to Product values.
P2A Conversion	Name of special routine which converts from Product to Algorithm values.
Description	Text description (flags contain hyperlinks to descriptive PDF files).
Comment	Text comments.

Appendix A

Level 1 Data Products

Standard Label - Contents & Description

GLAS Products begin with ASCII header records containing information regarding the processing which created the Product and the data contained within. These header records are exactly the same size as a Product data record and contain ASCII information in a slightly modified KEYWORD=VALUE format. In order to conserve space on the product, the header entries are not delimited by the record length, but by a semi-colon (;) and linefeed (ASCII 10).

By design, the first two header entries are the record length and number of header records. This allows product readers to verify the record length and jump directly to the first data record, if necessary. Most of the remaining information within the headers is directly applicable to the generation of metadata files for EOS ingest.

The following common fields are defined for GLAS Product Headers:

Table A-1 Common Product Header Elements

Keyword	Content Description
Recl	Record length in bytes.
Numhead	Number of header records preceeding product data records.
ReprocessingPlanned	
ReprocessingActual	
LocalGranuleID	Filename of this granule.
SizeMBECSDDataGranule	
ProductionDateTime	Processing data and time.
LocalVersionID	Version ID number.
SP_ICE_Path_No	
SP_ICE_GLAS_StartBlock	
SP_ICE_GLAS_EndBlock	
ShortName	Short name of product (corresponds to GLAS filetype).
VersionID	Version number.
RangeBeginningTime	Time of first data record.
RangeEndingTime	Time of last data record.
RangeBeginningDate	Date of first data record.

Table A-1 Common Product Header Elements (Continued)

Keyword	Content Description
RangeEndingDate	Date of Last data record.
PGEVersion	Version number of generating PGE.
AutomaticQualityFlagExplan	Automatic Quality flag explanation.
OperationalQualityFlagExpl	Operational Quality flag explanation.
ScienceQualityFlagExplana	Science Quality flag explanation.
Instance	Instance number.
cycle	Cycle number
time_between_contiguous_r	Time between contiguous records.
Range_Bias	Range bias value.
Timing_Drift	Timing drift value.
InstrumentShortName	Instrument name (GLAS).
PlatformShortName	Platform name (Icesat).
SensorShortName	Sensor name (LaserAlt).
EquatorCrossingLongitude	Longitude of equator crossing.
EquatorCrossingTime	Time of equator crossing.
EquatorCrossingDate	Date of equator crossing.
InputPointer	Name of each input product file used to created this product (one instances of this keyword appears in the product header record for each input product file used in creation of this product).
AncillaryInputPointer	Name of each input ancillary file used to created this product (one instances of this keyword appears in the product header record for each input product file used in creation of this product).
AncillaryInputType	File type of each AncillaryInputPointer value. (one instance for each instance of AncillaryInputPointer keyword.) File type corresponds to GLAS file types.
ReferenceOrbit	Reference orbit number.
laser_number	Laser identification number.
laser_number_beg_date.tim	Date/Time specified laser was first used.
detector_number	Detector identification number.
detector_number_beg_dat	Date/Time specified detector was first used
oscillator number	Oscillator identification number.

Table A-1 Common Product Header Elements (Continued)

Keyword	Content Description
oscillator_number_beg_da	Date/Time specified oscillator was first used
Photon Counters in use	Photon detector identification number.
Photon Counter_beg_date.t	Date/Time specified photon detector was first used

Appendix B

Level 1 Data Product Formats

B.1 Record Formats

B.1.1 Guidelines

The GLAS Data Product record formats were developed under the following guidelines:

- 1) Record size a multiple of 8.
- 2) Start elements on a 4 byte boundary; where not possible use pads or group smaller elements together to get to 4 byte boundary. Pad and move elements so that arrays start on 4 byte boundaries.
- 3) The output structures to build files should be grouped in descending size order, therefore group elements on file logically and in descending size order.
- 4) Data that occurs occasionally in the file should be put in the header. Specifically, data that are changing at a much lower rate than the record rate on the files, will be put in the header. These elements will not be shown in the record format.
- 5) Add spares.

B.1.2 GLA01

Fixed length, variable format records. For each second of data there is a header record and a varying number of waveform records. The number of waveform records depends on whether the telemetry data was sampled over ocean (2) or land (5). The header record contains all altimetry waveform information except the waveform and indicates whether the following records are ocean (short) or land (long) waveforms; the following records contain long or short waveform data until complete. While the waveform will always occur at 40 per second, the on-board flight software determines the number of samples from the on-board surface type. For land surfaces 544 samples are collected; for ocean surfaces 200 samples are collected

B.1.3 GLA02

Records are fixed length and format and occur once per second.

B.1.4 GLA03

Records occur at once per 16 second rate and are fixed format.

B.1.5 GLA04

GLA04 is a multi-file product. Within each file, records occur at once per second and are fixed format.

B.1.6 GLA05

Records are fixed length and format and occur once per second.

B.1.7 GLA06

Records are fixed length and format and occur once per second.

B.1.8 GLA07

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Abbreviations & Acronyms

ATBD	Algorithm Theoretical Basis Document
DAAC	Distributed Active Archive Center
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	NASA Earth Observing System Mission Program
EOSDIS	Earth Observing System Data and Information System
ESDIS	Earth Science Data and Information System Project
GLAS	Geoscience Laser Altimeter System instrument or investigation
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
ICESat	Ice, Cloud, and land Elevation Satellite
ID	Identification
IEEE	Institute for Electronics and Electrical Engineering
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
POD	Precision Orbit Determination
SCF	Science Computing Facility
TBD	to be determined, to be done, or to be developed
UNIX	the operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division
WFF	Wallops Flight Facility

Glossary

aggregate	A collection, assemblage, or grouping of distinct data parts together to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.
array	An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.
file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
item	Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.
Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.

Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and geo-reference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS ICESat spacecraft each orbit revolution count starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or constraining data unit associated with a EOS science community approved algorithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements.
pass	A sub-segment of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the DAAC or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS ICESat/GLAS Data Product produced on the DAAC or on the SCF. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
variable	Usually a reference in a computer program to a storage location.
